

Calculation of new PCU values at two busy intersections in Ernakulam District, Kerala

Parvathy Rajendran¹, Anson Joseph², Arun Dinesh³, Aswin Sajeevan⁴, Jeferin Johny⁵

¹Assistant Professor, Department of Civil Engineering, MGM CET, Ernakulam, Kerala

²Btech Scholar, Department of Civil Engineering, MGM CET, Ernakulam, Kerala

³Btech Scholar, Department of Civil Engineering, MGM CET, Ernakulam, Kerala

⁴Btech Scholar, Department of Civil Engineering, MGM CET, Ernakulam, Kerala

⁵Btech Scholar, Department of Civil Engineering, MGM CET, Ernakulam, Kerala

Abstract –In developing countries like India there is always a major consideration in the transportation sector. New developments are coming day by day in this area. But still India is having heterogeneous traffic condition and also not following lane discipline. The number of vehicles in the road and the vehicular characteristics and design also changes. So a major consideration is to be given for converting the all vehicles to a common standard ie the Passenger Car Unit(PCU). But as the vehicular dimensions are changing there is a need for revising these PCU values atleast at the intersections. This paper focuses on the determination of the new PCU values for different vehicle categories at signalized intersections under mixed traffic conditions. Traffic volume studies are done to determine the number, movement and classification of vehicles at the given location, which was done by the manual method.

Key Words:Heterogeneous traffic, Passenger Car Unit(PCU), Vehicle, Intersections

1. INTRODUCTION

The road traffic in India is highly heterogeneous comprising vehicles of widely varying static and dynamic characteristics and the vehicles share the same road space without any segregation. The non- uniformity in the static and dynamic characteristics of the vehicles is normally taken into account by converting all vehicles in terms of a common unit known as Passenger Car Unit (PCU).

Different vehicle types occupy different spaces on the road, move at different speeds, and start at different accelerations. The behavior of drivers of the different types of vehicles may also vary considerably. This causes a problem for designing roads, intersections, and traffic signals. A uniform measure of vehicles is thus necessary to estimate traffic volume and capacity of roads under mixed traffic flow. This is rather difficult to achieve unless the different vehicle types are stated in terms of a common standard vehicle unit. For these reasons, the concept of Passenger Car Unit (PCU) or Passenger Car Equivalent (PCE) was developed and it became a common practice to convert the other vehicle types into PCUs.

Different methods for finding the new PCU values are considered and from that the best method is adopted for the present study. Two busy intersections are taken for analyzing the PCU values. The traffic volume details and the vehicular characteristics are studied for the work.

2. OBJECTIVES

1. To analyze whether there is any change in the PCU values at the signalized intersections.
2. To understand the variations in PCU with respect to the vehicular dimensions and the speed of the vehicle

3. LITERATURE REVIEW

Sumit Rana & Anil Kharb (2017) conducted a study at Ghantaghar Chowk in Karnal city considering almost all classes of vehicles commonly found in Karnal city, India. They concluded that the PCU value of each vehicle is not a constant but varies with several factors such as proportion of other classes, level of service, volume to capacity. In their study the average value of speed and time headway is taken. Parvathy R et al (2016) studied the development of new PCU values and the effect of the length of passenger cars on PCU. In this study an attempt was made to learn the characteristics of mixed traffic flows at identified intersections. This work provides the details of an empirical study performed to determine the PCU values for different vehicle types so that a comparison of results with PCU factors recommended by IRC code is possible. Moreover, an attempt was made to find the effect of the length of passenger cars on PCU. The PCU values obtained in this study are compared with the previously determined values. Emy Paulose & Neethu C R (2018) studied the design of a signalized intersection depends on the PCU values and saturation flow by convert heterogeneous traffic into homogeneous traffic Methodology consist of study area, data collection , estimation of PCU values and estimation of saturated flow rate. Intersections selected for this study have level gradient on all approaches and least interference to entry or exit traffic due to pedestrians, bus stops, parked vehicles, etc. All the approaches of the intersections reach saturated stage for whole or majority of the green interval during almost each phase during peak hour as traffic flow is very heavy.

2. METHODOLOGY

The methodology is given in following sub headings

2.1. Study area

Two four armed pre- timed signalized intersections were selected for the present study. Intersections selected for this

study have level gradient on all approaches and least interference to entry or exit traffic due to pedestrians, bus stops, parked vehicles, etc. All the approaches of the intersections reach saturated stage for whole or majority of the green interval during almost each phase during peak hour as traffic flow is very heavy. Two selected signalized intersections are shown in figure 1 and 2.

1. SN junction Thripunithura
2. Kakkanad



Fig 1. Traffic Delay at S N Junction, Thripunithura



Fig 2. Traffic Delay at Kakkanadu Signal

2.2. Data Collection

In this study, traffic turning movement data of the subject approaches of the intersections was recorded by using a portable digital video camera mounted on a stand to cover all approaches of the intersection so that it clearly capture view of approach roads. Continuous pictures of the traffic flow to be recorded with the video camera for morning and evening peak hours.

2.2.1. Speed Calculation

Speed at each intersection calculated by dividing distance by time taken to travel that specific distance. Table 1 showing speed calculation at SN Junction and table 2 showing speed calculation at Kakkanad. The speed of vehicles when entering into the intersection is relatively very low because of heavy congestion at the existing intersection

Table-1: Speed distribution at SN Junction

Direction	Karingachira (kmph)	Ernakulam (kmph)	Vaikom Road(kmph)	Eroor (kmph)
Vehicle				
Bike	2.3	2.1	2.6	2.3
Car	2.6	2.98	3.24	2.8
Three Wheeler	2.23	2.08	2.8	2.1
Pickup	2.26	1.94	2.5	1.8
Bus	1.76	1.77	1.9	1.65
Lorry	1.57	1.65	1.75	1.47

Table-2 :Speed distribution at Kakkanadu Junction

Direction	Karingachira (kmph)	Thrikkakka (kmph)	Infopark(kmph)
Vehicle			
Bike	0.3	2.56	2.25
Car	2.8	2.93	2.47
Auto	2.73	2.73	2.32
Pickup	2.52	2.6	2.08
Bus	1.87	2.06	1.59
Lorry	1.67	1.72	1.48

2.2.2 Calculation of projected area of different vehicles

The length and width of different vehicle is measured and then projected area of that particular type vehicle is calculated. It is shown in table3. It is necessary for calculating new PCU value at that intersection.

Table -3: Projected area of vehicles

Vehicle	Dimension (mxm)	Projected Area(m ²)
Bike	1.85 X 0.63	1.2
Auto	3.2 X 1.4	4.48
Pickup	3.35 X 1.56	5.22
Car	3.67 X 1.6	5.8
Bus	8.45 X 2.2	18.59
Lorry	9.12 X 2.3	20.97

3. DEVELOPMENT OF NEW PCU VALUES

Present roadway and traffic conditions at both intersections were observed and analyzed. Using the present traffic data, new PCU values are developed by adopting Chandra's method. The PCU may be considered as a relative measure of the relative space requirement of a vehicle class compared to that of a passenger car under specified set of roadway, traffic and other conditions. If the addition of one vehicle of a particular class in the traffic stream produces the same effect as that due to the addition of one passenger car, then the vehicle class is considered equivalent to the passenger car with a PCU value equal to 1.0. The PCU value of particular vehicle class may be considered as the ratio of the capacity of roadway when there are passenger cars only to the capacity of the same roadway when there are vehicles of that class only. PCU values for different classes of vehicles were estimated for saturated flow condition using equation.

$$PCU = A_i \cdot V_i / A_c \cdot V_c \text{------(i)}$$

Where,

PCU_i = Passenger Car Unit of vehicle type i

A_i = Area of i^{th} vehicle

A_c = Area of passenger car

t_c = Speed of car in km/hr

t_i = Speed of vehicle type i in km/hr

New PCU values obtained from site are quite different from the values given in code. For signal design purpose or to determine the saturation flow rate, PCU values applicable to current conditions need to be developed instead of depending on the old PCU values given in code. The new values are given in table 4 and 5.

Table-4: New PCU values at S N junction

Vehicle	Codal Value	Karingachira	Ernakulam	Vaikom Road	Eroor
Bike	0.5	0.24	0.3	0.26	0.25
Car	1	1	1	1	1
Auto	1	0.9	1.1	0.89	1.02
Pickup	1	1.03	1.3	1.16	1.3
Bus	3	4.7	5.3	5.4	5.5
Lorry	4.5	5.9	6.5	6.6	6.7

Table-5: New PCU values at Kakkanadu

Vehicle	Codal Value	Karingachira (kmph)	Thrikakkara (kmph)	Infopark (kmph)
Bike	0.5	0.3	0.24	0.23
Car	1	1	1	1
Auto	1	0.8	0.91	0.82
Pickup	1	1	0.97	1.1
Bus	3	4.7	5.8	5.08
Lorry	4.5	6.17	6.1	6.03

4. RESULTS AND DISCUSSIONS

The new PCU values obtained at all the intersections found to be different from the codal values. For any transportation engineering work the conversion of heterogeneous traffic to a common term is necessary. For that the use of PCU values is important. But the PCU values may vary at intersections by the change in vehicular dimensions, speed characteristics of vehicle etc. From the present study it is clear that at all the intersections the values varied considerably. If the new design of signal system is based on the corrected PCU values then there will be changes in the signal timings.

5. CONCLUSIONS

The revised PCU values at the selected intersections can be used for the new signal design procedures. The new traffic volume calculated based on the new PCU values will be higher than the existing traffic volume which results in more effective signal design systems.

REFERENCES

1. Emy Paulose & Neethu CR, "Analysis of saturation flow at signalized intersection", International Research Journal of Engineering and Technology, Vol.05 Issue.03, (2018)
2. Hitakshi Barre & Sunil sugandhi, "Modified PCU for highway traffic: A review", International Journal of Engineering Science & Research Technology, (2017)
3. Parvathy R, Sreelaltha T, Reebu Z Koshy, "Development of new PCU values and effect of length of passenger cars on PCU" International Journal Innovative Research in Science Engineering and Technology (2016).
4. Sumit Rana & Anil Kharb, "Development of PCU, case study of Karnal district of Haryana", International Research Journal of Engineering and Technology, Vol.4, Issue 5 (2017)

BIOGRAPHIES



Parvathy Rajendran is working as Assistant Professor in the Department of Civil Engineering at MGM CET, Ernakulam for 7 years. She received Mtech degree in Transportation Engineering and B Tech in Civil Engineering from Govt. RIT Kottayam. She published three papers in various international journals. Her areas of interest are in Transportation planning, traffic signal designing.